Importance of individual capacity building for successful solar program implementation: A case study in the Philippines

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Abstract

Solar energy is often chosen as the enabling technology for many off grid, rural electrification projects. In many situations photovoltaic systems (PV) prove to be a highly effective means of meeting essential needs such as lighting for homes, schools and community centres, as well as remote telecommunication, fresh drinking water and vaccine refrigeration. Throughout the Pacific-island region, countries such as the Philippines have experimented with small scale rural energy projects for over three decades. There are lack of adequate 'individual' technical training and appropriate social preparation activities has often resulted in project failures due to poor maintenance, abuse, poor installation, and lack of understanding by the system owner, operator or local technician. This research was aimed at investigating the importance of individual training in capacity building programs for solar home system (SHS) technology transfer projects. The focus is on the analysis of the effectiveness of the individual training component in various projects in the Philippines. A survey has been undertaken which included a series of SHS site visits and individual surveys with system owners and operators, and Focus Group Discussions with other project stakeholders. Survey results show that adequate user and local technician training is an important factor in successfully implementing rural electrification through PV power systems. However, for training to be successful there must be a consensus of what the target performance ~~behaviours~~ behaviors should be and how they should be measured. The most basic requirements for successful training are that the training reaches to the right people at the right time and delivers the right content.

Keywords: Capacity building; Training; Solar PV; Philippines; Users

1 Introduction

In rural areas of developing communities electricity is essential for telecommunications, powering applications in schools, community centres and health facilities. Lack of access to reliable electricity is one of the major factors that inhibits opportunities for the development and operation of many enterprises. At the domestic level it can improve individual and family productivity and lessen the burden of many domestic tasks. Access to energy has proven fundamental to economic growth and a catalyst for alleviating poverty. However, supplying electricity by grid in these small and geographically remote and isolated areas often near impossible and not cost effective [1]. People not served by centralized power grid mostly rely on solid fuels and fossil fuels like kerosene and diesel for most of their energy needs. Fossil fuels are often imported, and their use leaves local economies vulnerable to global price fluctuations and disruptions in supply. Transporting these fuels to remote locations can be expensive and difficult, and their indiscriminate use can also be harmful to health and the environment.

Photovoltaic systems, such as Solar Home Systems (SHS), are being promoted by both governments and international aid organizations as a feasible and cost effective alternative for the basic electrification of rural households [2]. A number of successful SHS pilot projects received widespread attention such as Bangladesh Solar Home System project by IDCOL [3,4]. After these success stories, solar home systems gradually came to be adopted as a viable option for rural electrification.

The idea to provide rural households and small communities with solar energy projects in the Philippines is not new. Throughout the pacific-island region countries such as the Philippines have experimented with small scale rural energy projects for over three decades. Since 1970 many such projects were implemented in the Philippines in both the public and private sectors with a total investment estimated at $100 million [5]. The Government of the Philippines has been the recipient of aid funding for renewable energy projects from many of the major donor organizations (multilateral and bilateral) over the past 20–30 years. The early projects were mostly driven by international cooperation and funding agencies.

The majority of these early projects were donor/aid driven and often lacked a comprehensive implementation plan to ensure sustainability in the technical transfer process. A detailed study of many of the early projects found that nearly 20–25% failed due to barriers experienced in the technology transfer process [5]. The earliest project failures were usually related to technical problems with the system components. This could be expected in the transfer of new, immature

technologies. According to Mrohs (1998) [6].

'In the 1980s, many programs badly underestimated the need for repair and maintenance, in the mistaken belief that PV systems needed little or no support and could be maintained by untrained local residents. Many systems were simply abandoned due to failure'.

Despite of loads of prospect, rural electrification with solar home system is still having lack of success. According to the literature the main reason for failures are [4,7–9]:

- Lack of information on user experience
- Service infrastructure and system maintenance
- Limited choice of system size
- Component failure and reliability in operation

The main reason of failure in most of the PV projects is to overlook maintenance and service and not include as a part of project development.

This research aims to investigate the importance of training in capacity building programs for SHS technology transfer projects. It will also aim to examine the importance and relevance of various factors in the selection of training participants, training curriculum and follow-up & monitoring programs. The study then analyze the effectiveness of the individual training component in various projects in the Philippines the need to devote time and financial resources to capacity building programs that specifically target the system technicians and end-users in solar technology transfer projects.

2 Background: PV projects and training in the Philippines

The Philippines is a country comprising over 7000 islands and nearly 89.7 million people [10]. According to the Dept of Energy 40% of the population (including 79% of the country's poor) resides in rural areas [11]. The Philippine's department of Energy (DOE) has classified over 8000 barangays (or small villages) as 'un-electrified'. This includes nearly 10.6% of the population, approximately 9.5 million people, who lack access to electric service [10]. Where it is available, even for limited hours during the day, electricity in rural regions is more expensive than in metropolitan areas, while average household incomes are substantially lower. After dark, the productivity of individuals and households is limited by a lack of adequate lighting, usually by kerosene wick lamps.

To address this issue the government of the Philippines has developed the Philippine Energy Plan (PEP) which contains an extensive rural electrification program. This plan supports the premise that electric power is needed to foster economic development, particularly in the rural areas. The government has also adopted the Electric Power Industry Reform Act of 2001 which, as a matter of policy, has a commitment to pursue total barangay (community) electrification in line with efforts to provide a better quality of life for all, particularly those in rural areas. In doing so, the DOE has estimated that 20% to 50% of the un-electrified barangays as well as the un-electrified households in grid connected communities would be served most economically by "off-grid" power systems that provide a lower life-cycle cost electrification option than extending the grid [12].

Solar energy was chosen as the enabling technology for many of these off grid electrification system projects. In many situations photovoltaics (PV) proves to be a highly effective means of meeting essential needs such as lighting for homes, schools and community centers, as well as remote telecommunication, fresh drinking water and vaccine refrigeration. The systems are versatile, have extremely low operating costs and promote a sustainable environmental ethic. Solar Home Systems (SHS) are small-scale, modulated, solar home lighting systems which usually contain one or two PV modules, a single battery with charge controller and one to three energy efficient lamps.

2.1 Importance of training in SHS technology transfer

Despite many lessons learned and many thousands of new small-scale solar installations in the Philippines, projects are often still plagued with inadequately trained owners, operators, installers and system failures [13,14]. Many projects still focus on the technology or 'hardware' itself and fail to address the development of 'software' or the knowledge base to make the technology work. This includes the transfer of experience, knowledge, skills and practices in a process called 'capacity building' and training. Lack of training becomes very evident when systems fail or have their lifespan drastically reduced due to user error, abuse, or poor installation.

In most cases the remoteness of the site leaves the end user of the technology ultimately responsible for all ongoing maintenance and operation of the system. For this reason the role of individual capacity is often underestimated and the scale and scope of resources committed to individual development is too often insignificant relative to the magnitude of its need and potential impact. Therefore, adequate training in system operation and basic maintenance would alleviate these issues as well as play a very critical role in system sustainability.

A well designed and executed training program for individual capacity building alone will not determine the success or sustainability of a technology transfer project. Problems that are due to poor communications, inadequate facilities or equipment, financial constraints, bad organization, poor institutional or organizational capacity or a variety of other situations will not go away with a good training program. However, well equipped and knowledgeable system owners, operators and installers will greatly

increase the chances of attaining a sustainable SHS technology transfer project.

3 Research methodology

Fig. 1 shows the steps of the research. The research employed two methods of data collection: a survey of available literature and field data collection which included a series of SHS site visits and field surveys and Focus Group Discussions with other project stakeholders. Data are then processed and analyzed and present as lesson learned and recommendation as shown in Fig. 1.

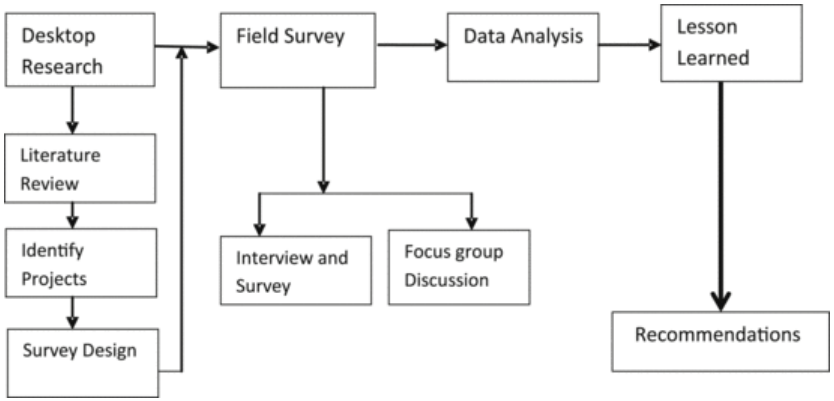

Fig. 1 Methodology of the study.

The literature reviewed was used to gain information about the projects and usefulness of training. This help to select the study area. The data gathered from the literature review were used to design the survey questionnaire and focus group discussion guide questions. The user's survey questionnaire was designed to collect information on the beneficiaries experience with capacity building and training programs associated with their solar installation, knowledge of the installed system and technologies, operation and maintenance and also their personal satisfaction with the system and the training they received. All participants in the site surveys were beneficiaries of one of the three Palawan projects: Accelerating Community Electricity Services using Solar (ACCESS), The Philippine National Oil Company (PNOC), or Solar Home System Development Project (SNSDP) [12].

Ethic approval was obtained for this study. This approval is granted by the Murdoch University Ethics Committee. To ensure that all participants voluntary participate in this study, an information letter was given and consent was asked before interview or questionnaire survey was conducted. Around 50 participants were selected from 10 communities for questionnaire survey. Participants were chosen randomly from the list provided by Philippino Department of Energy (DOE). Due to unavailability of some participants, only 21 project participants (beneficiaries) were surveyed in a total of 9 barangays.

The questionnaires were conducted in the vicinity of the system to which the questionnaire pertains and included private homes, community centers, schools, and public areas.

Focus Group Discussions (FGDs) were executed with project implementing agencies. Each group had 4 participants. The participants included the Officials from the Project office of the Palawan SHS Distribution Project, Representatives from the DOE's Rural Power Project, AMORE, DAR-SPOTS, DOE projects, Private contractors, including Shell Solar, Solar Co who managed installations and training activities for the Palawan Projects and Past employees in charge of training, design or management for BP Solar, Solar Power Technology Support Project to Agricultural Reform Communities (SPOTS) and Alliance for Mindanao Off-grid Renewable Energy (AMORE) projects. Five FGDs were performed and the participants for the FGDs were selected based on their involvement in the Palawan projects or other similar projects implemented in the Philippines.

The data were qualitative in nature. Analyzing qualitative data involves reading through the interview or focus group, transcripts and other data, developing codes, coding the data, and drawing connections between discrete pieces of data. The results were compared with relevent literatrure. A list of lessons learned was formulated to show the importance and effectiveness of the individual training component in various projects in the Philippines.

4 Survey results

The data collected from the participant surveys and FGDs was consolidated and catagorized into the following target topics. Each topic reveals an important aspect of individual capacity building programs:

- *Project Preparation*
- *Selecting Training Participants*

- *The Training Program*

4.1 Project preparation

Overall project design and structure can greatly influence end-user capacity and must be briefly addressed to understand how it may have affected SHS end-users in Palawan. Many components of the project design are relevant in this discussion and the data gathered for this subject were primarily from FGDs.

According to a private company that was responsible for system installation, the Palawan projects would be more sustainable if they could have teamed with a financial institution that specializes in micro-lending. People would then pay a realistic cost for their systems and be more likely to care for them. According to the company representative and FGD, subsidizing the systems does not work. It was found that when technology is transferred into a community, especially, technology such as PV that requires a large capital investment, efforts must be made to present the consumer with a price that is not too artificially low from excessive subsidies.

Problems associated with “dole-out” projects include system failures due to lack of user need and understanding, and apathy. The projects implemented by the Provincial Government of Palawan have suffered because of such political motivations behind the program (the SNSDP). Many project recipients recognized these problems.

4.1.1 Site location

One participant mentioned that site selection is very important. Some projects (such as SPOTS) were intentionally selected because of the proximity of other SHS projects and corresponding technical support networks. However, many FGD participants commented on the fact that typhoons, a bad road network and remoteness of the sites prevent projects from expanding. Remoteness also creates a large travel expense and commitment for external maintenance providers or money collectors.

4.1.2 Community needs assessment & training plan

From the questionnaire survey it has been found that the technological needs of the project recipients were not completely acknowledged or not addressed at all. Fig. 2 shows the summary on community involvement in the project development data.

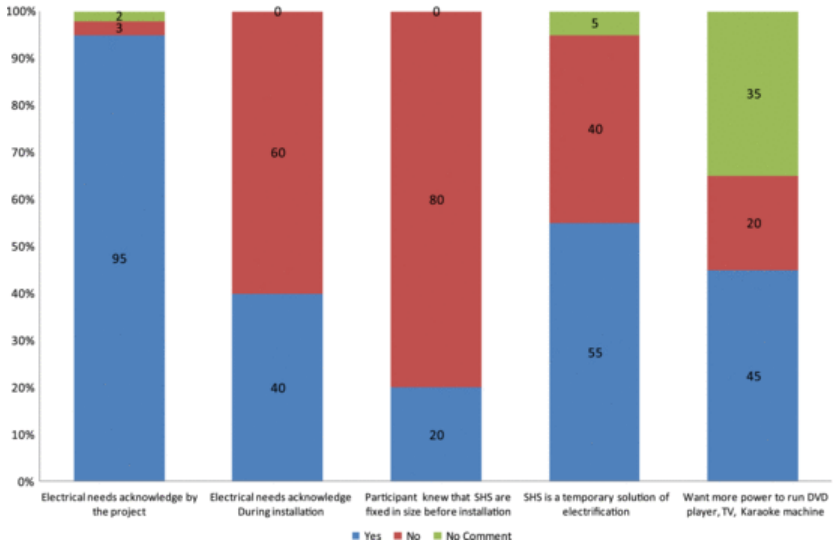

Fig. 2 Summary from the survey results on community involvement in project development for the Palawan SHS projects.

From figure we can see that most of the participant (80%) did not know that SHS are fixed in size its size and how much power it could provide. This lead to dissatisfaction after the system installed as they want more power to run DVD player, TV, Karaoke machines etc. According to the FGD's the AMORE project acknowledged that their training plan resulted from an evaluation of local community capabilities and needs assessment for training and technical assistance support. They designed a

> “… comprehensive training plan for the duration of the project, which was prepared to identify training needs in more detail. Inputs to this training plan included an evaluation of local community capabilities and needs assessment for training and technical assistance support,” [12].

4.2 The training programs

4.2.1 Training accreditation/certifications

There is currently no standardized accreditation or certification program for PV technician or end-user training in the Philippines. There was no coordination of training, no rational training development process, and little follow up effort to determine whether or not training activities have actually had any long term benefits. Some of the findings are given below:

- None of the participants were ever tested on the skills they acquired during orientation/training
- Each of the Palawan projects developed its own training programs or depended on contractors or manufacturers to provide training materials and conduct trainings
- Most FGD participants acknowledged a need to standardize the renewable energy training curriculum

4.2.2 The training curriculum

4.2.2.1 Technical training Very little data was collected from questionnaire regarding the training received by village technicians because only one of the 8 communities visited contains a locally trained technician. Participant training on system technicalities was surveyed by measuring the beneficiary's knowledge of their system. End-user participants were asked to identify, list, and briefly describe all of their system components. Fig. 3 below shows the percentage of the surveyed participants that recognized each component.

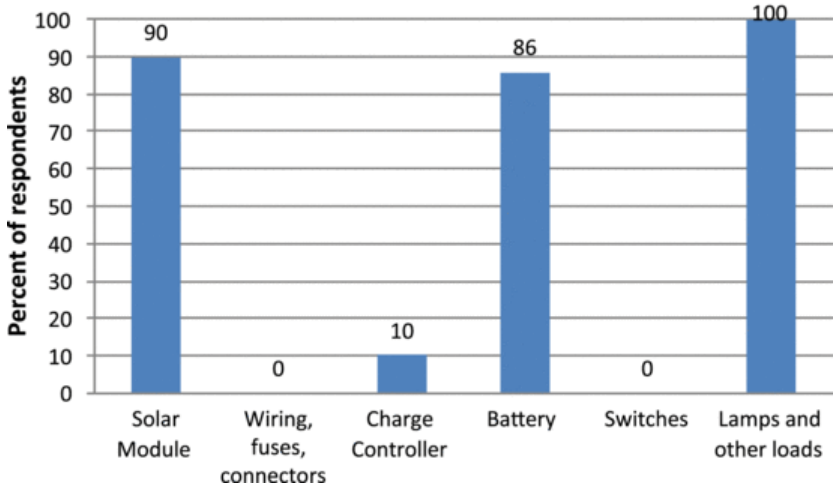

Fig. 3 Percentage of respondents that recognized the solar system components.

From Fig. 3 we can see that 90% of the respondents were aware of the solar panels and their function in this project. All respondents (100%) recognized the lights as a component of the system and 86% were aware of the battery for energy storage. However, only 10% of the surveyed participants were aware of the battery charge–discharge controller. The charge controller helps users understand and monitor their level of use and helps to maintain a satisfactory state of charge on the battery, which helps to keep battery life longer.

Table 1 presents the number of participants that acknowledged each component and provides some brief notes regarding the responses. Survey questions also tested the participant's knowledge of the technical specifications of each system component. Around 85% of the participants know about battery bank voltage but only 19% know about battery capacity. Only 9% knows about module voltage and what could reduce the voltage like shading etc. They do not have any idea of why the module needs a tilt and why it is important. Many of the PNOC installations have an incorrect angle.

Table 1 Participants' knowledge of system components.

Actual components of each system	# of participants (out of 21) that acknowledged the system component	Notes
Solar module (s)	19	One participant knew thee was 'something' on the roof but didn't know what it was or what it did
Wiring, fuses and connectors	0	
Battery charge controller	2	2 participants called it a 'Control Box' which actually contained both the battery and charge controller.

Battery bank	18	
Switches	0	
Lamps/other loads	21	

The project participants were asked what type of maintenance is required and completed for each of the system components. Ten percent (10%) of the participant beneficiaries said they do no maintenance whatsoever on their system.

Overwhelmingly, project and training designers, managers and technicians believed that some degree of user-based technical training was extremely important. Around 50% of the survey participants mentioned that the most important need for training is to develop an understanding of system limitations and maintenance. Two FGD participants downplayed the need for users' technical training stating that beneficiaries should only be trained in whom to contact in case of problems and trained to understand the payment structure. FGD participants also expressed a need for developing local technician capacity as in some cases external technicians need to travel for many hours to replace even a small fuse.

4.2.3 Non-technical training

Training activities that took into account non-technical aspects of SHS project implementation were examined in this study. Subjects that have been identified in this category are: the environmental/social benefits of RE technology, Financial Planning, and Personal and Community development.

- 100% of project participants claimed that their training did not include non-technical aspects such as leadership, community building, accounting, business development, etc …
- Many participants (85%) and three FGD members commented that training programs should not include non-technical aspects.
- Three FGD participants mentioned that it is important to include the broader picture of the environmentally advantageous implications of using RE technologies. “This is especially evident in Palawan because the island is “pristine” and people already have an environmental ethic. This adds to the success rates of the projects.”

4.2.4 Financial training

Financial literacy has been identified by many programs as an important topic in any technology transfer projects. Most SHS deployment projects incorporate some sort of a financial structure for the participant to understand the financial plan and appropriately pay off their system. When asked about the content of their training program:

- 70% of the participants stated that the payment plan was the largest focus of the training,
- Participants said that the greatest benefit of the SHS system was that the systems were ‘cheap’ or ‘free’ and that they were saving money by not spending as much on fuel for their generators or kerosene for lamps,
- Data collected in the FGDs indicated that the initial, up front, capital cost of the technology and the ongoing maintenance costs are the largest barriers to a project's success.
- Two FGD participants mentioned that training on financial planning was not necessary because, “… if project participants really have a need for the system they will find ways to pay for it even if a financial structure is not in place or they have not received any financial training.”

4.3 Training approaches

Many different models have been used to train project participants.

- 80% of participants claimed that they did not receive any formal training, just an orientation to the system, the warranty and the financial structure.
- One participant mention, *//....First, basic orientation on PV must be done and be done ‘classroom type’ … .second, hands-on installation training. It must be noted that they [locally trained technicians] become part of the installation teams to learn how it is being installed and tested. Third, site visits after a few months of operation are needed to check on the experiences of the participants and check what problems they encounter and explain to them why it did happen…//.”*

Another FGD participant noted that the content of the training programs,

“//… will bore them during discussions … the depth of the subject may be too deep for the participants to comprehend. Trainers should elaborate practical answers to problems ~~-~~ not by explaining principles and theories written in the book as the participants are ordinary people like farmers, ~~labours~~labors, etc … //”

Training programs used in Palawan employed the traditional “didactic’ style of training which is content-focused. In this type of training information is passed in one direction – from trainer to trainee. This didactic approach assumes that the learner's main problem is lack of knowledge. A large disadvantage of this approach is that the simple transfer of information from trainer to trainee seldom assures that the trainee will put the information into practice. But in reality, Palawan participants were able to recall the information gained in their training sessions but failed to put it into practice.

There was no hands-on learning in the Palawan projects. A United Nations report that analyzed RE community based training stated that, “Hands-on training is more effective than classroom training but sufficient classroom training must be included to ensure that there is full understanding of the hands-on component. As a general rule, at least half of training activities should be of the hands-on type and it should as closely as possible emulate the actual equipment or activities the training is intended to support [15].

In Palawan projects users fail to relate the training with the installed system as training was arranged before the installation.

4.4 Selecting trainers

Data was collected on the qualifications and attributes of the trainers who worked with project technicians and participants. The majority of the participants (80%) stated that the trainers came from Puerto Princessa (the Provincial Capital). All respondents (except one) agreed that the training or orientation was conducted in their local language/dialect Cuyano.

These comments are also supported by the results obtained from the FGDs. Most people involved with the projects mentioned that the training component of the project is contracted out to either product manufacturers or installers. The contractors are responsible for training the technicians and the end-users. One participant stated that, // … *Training for the technician is quite detailed so that the technician will be able to repair any part of the system … //*" It was also mentioned by the participants that the projects are very dependent on external technicians who are not located in the communities, which may create problems in the near future. The following are some findings from the survey.

- Only 1 barangay had a local technician and many of the residents were not aware that he was a ‘trained technician’.
- Each barangay supposedly had local technicians chosen by the Barangay Captain for special training.
- One FGD participant stated that, *// … A separate training is conducted for perspective technicians that are chosen by the barangay captain. Usually there are about 10 people who are trained on the repair and maintenance of the systems. These technicians are involved in the installations …//.*

Three FGD participants had different perspectives of train local technicians as follows:

- Local technicians migrated to city after they got trained
- Some of the trained technicians are not competent or confident enough to fix problems
- Difficult to find local people who were actually interested in receiving additional technical training
- There were problems of not paying the technicians. According to a survey respondent, this problem influences the quality of system maintenance in a community.
- The development of sound financial structures to provide incentives for local technicians has been the topic of many other research investigations.

4.5End-users training

The Palawan projects that were examined were designed under the assumption that most SHS systems are not well maintained by users and a centralized maintenance system must be organized. This has been true, in most cases, and creates a complex problem because of the interaction of geographical, economic, technical, social and political considerations.

- According to the survey 60% of the respondents mentioned that the operation and maintenance were their own responsibility and the systems have very rarely or never been visited by local or external technicians.
- Despite the fact that each of the Palawan projects only contained a one-year service warrantee, as long as the systems provided a reasonable number of hours of light, very little was done as far as regular or preventative maintenance.
- By the time the SHS systems no longer provided satisfactory service problems have accumulated and battery life has been seriously shortened.

It was also mentioned by the participant that end-user training is extremely important even in projects that have built in maintenance contracts with third parties. It was generally accepted that users should, at the very least, have a basic knowledge of the system limitations and maintenance. However, there were some different opinions regarding user training. Some survey participants mentioned that it is important for the users to recognize a problem and what may be causing it but they don't need to know how to

fix it.

// … That should be done by the recognized maintenance worker … //.

Three participants believed no user training was needed while other users wanted complete technical training to fully understand and be able to fix the systems themselves.

4.6 Training women/children

Training orientation programs for SHS systems averaged in size about 24 participants ranging from 8 to about 50 people in total. Fig. 4 shows the percentage of men and women who participated in the survey.

- In most of the sessions there were only one or two women present and sometimes a few children.
- 33% of the surveyed domestically owned and operated SHS systems were predominantly operated and maintained by the women,
- 20% were jointly operated by both husband and wife
- 47% were operated exclusively by men

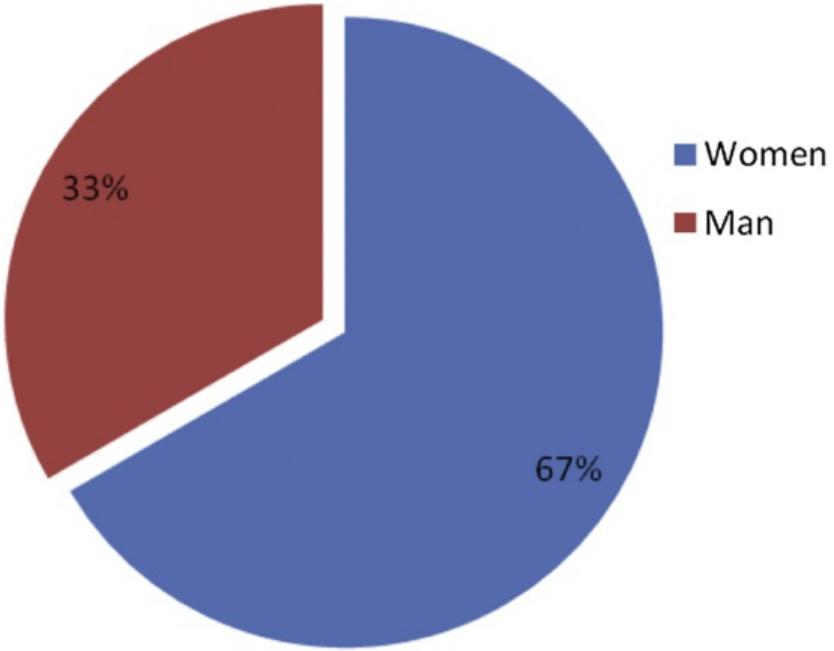

Fig. 4 The percentage of men and women who took part in the survey.

From survey results, it has been has found that in most projects under the survey area, women are the ones who are generally around the systems all day and are the ones that are usually responsible for looking after things around the home. The following comment came from one FGD participant.

// … Women have been found to have a better understanding of the systems and are better at record keeping, keeping the systems clean, and being honest … //.

Generally, the men do not stayed home most of the time during the day and in the evening. According to a participant.

// … off in the fields working, drinking, or gambling and are not intimately involved in the system … //.

In some of the surveyed Palawan projects, children were involved in system operation but not maintenance.

4.7 Training materials

4.7.1 Written and visual materials

Users were surveyed to determine to what extent written material was used in the training process. Each recipient in the Palawan projects received a packet of literature as part of their training/orientation. When asked about the content or existence of this literature 30% of the participants said they received no written material aside from a one page description of the project, 25% of the participants claimed to have received literature about the project, their contract and financial information, but were unable to produce it upon request, 45% of the participants had the written material readily available near their system. However, 33% of the participants admitted to not ever reading the papers or were unaware what was inside the folder.

4.7.2 Hands-on activities

Surveys examined the extent in which formal training programs ensure practical learning. This included how 'learn by doing' and other participatory techniques were considered in training programs. Participants were asked about the trainee's experience with this learning technique. Nearly all the participants were home when the installation took place but very few (15%) actually participated. In each of these cases the participant was only involved in selecting battery and lamp locations, cutting a tree, or making space for the installation. None of the participants was involved with any of the more technical aspects (wiring, testing, etc ...).

With a lecture-style orientation and no hands on activities as part of the training program, it was interesting to hear what project designers and implementers had to say in a FGD about the same project:

- Training program designers agreed that, there should be about 50% lecture and 50% hands-on training. Otherwise the participants will fall asleep. // ... users must be able to experience hands on activities. Normally if they have been trained without hands on they will still be hesitant to touch the system ... //.

4.7.3 Allotted time and location of training

Less than ½ day of training activities is all that was received by the participants in all three of the SHS projects that were examined on Palawan. All 20 participants surveyed attended the training or orientation program in their community in a communal building or 'barangay hall'.

- In the FGDs one participant stated that, // ... There needs to be significant time allocated for participant and technician training. Projects like the MSIP were done in haste and in a big hurry because of security concerns. Hence, nobody was adequately trained. This has lead to very high failure ... //.
- In the SPOTS midterm review, "It was evident that the trainees experienced some sort of "information overload" due, in turn, to the information blitz resulting from the rapid pace of the conduct of trainings relative to the assimilative capacity of the participants."

5 Discussion

The success of training programs can be influenced by many factors during the planning and preparation phases of the project development. It was proved from the survey finding that training is an important component of the project specially solar home system. There is a need for both technician and users training [4,8,16–18].

In Palawan project, training activities were not clearly considered which may have resulted in higher and unachievable maintenance costs to the participants. Training is important as mentioned by literature to make a project sustainable and get reliable power The financial structure and motivation for project implementation in the Palawan projects was aimed more toward completing the projects, rather than developing the necessary capacity of the project beneficiaries to keep the installations sustainable.

From the FGD we can see that the use of large subsidies or government "dole-outs" not only disrupts private enterprise and the advancement of a PV market it lowers a recipient's level of 'personal ownership' of the project and often directs inadequate time and resources toward user capacity building. Instead of "dole-outs", a well organized financial structure is required to collect the monthly fees to operate the maintenance program [19].

Most of the end users were given very little to no input on the type of system that they were to receive. The Palawan projects were highly under-valued the importance of user's preference and need. According to Nieuwenhout et al. (2001) [2] user preference concerning the number and location of lights, and suitability for other appliances, must be taken into account to make the project successful, which in the Palawan project, systems that did not taken into account. The remoteness of many of the Palawan Sites greatly hindered the ability for the communities to readily receive technological 'after sales' support.

Community consultation is very important to maintain good relationships with the users before program design [8]. Many of the issues and problems that have arisen in these projects could have been alleviated by the development of a thorough technician and user assessment and training plan and involving the community in the plan. This type of plan did not exist in the Palawan projects and should have been devised from a needs assessment during project planning in the communities.

Survey showed that the Palawan project did not trained the local technicians. The training of local technicians has proven to be one of the instrumental criterion for sustainability [4]. Especially in projects that aim to serve very remote rural communities, the dependence on external technicians is not practical because they usually live in distant urban areas. Although, it is not cost effective or practical for these individuals to service isolated rural projects, the need for adequately trained local technicians/installers was clearly identified. However, the programs' aim to effectively train and maintain these local technicians met with very limited success in the communities. Local people who have interest in the subject should be targeted and trained to fill these positions. The most effective training programs will target candidates that have the greatest preparatory knowledge and experience, and who will have the most assured opportunity to implement the new skills after the training program is over [20]. In addition to the training of local technicians, a system needs to be put into place that offers incentive for them to remain and work in the communities.

FGDs conducted for this study as well as training models, case studies and lessons learned from a variety of other sources revealed that past efforts in training local technicians have failed for a variety of reasons including incidents of 'Rural Exodus' or 'Brain Drain', incompetence, and a lack of confidence in conducting repair and general lack of interest of the system. Although not evident in Palawan because of the lack of local technical training, 'brain drain' has directly led to project failure in several other instances because of the relatively rapid turnover of personnel, particularly field maintenance technicians. One strategy to minimize this effect is to," encourage a diversification of economic activities, improving health conditions, and improving the quality of life for the inhabitants" [21].

End User training was also determined to be of utmost importance. In the Palawan projects 28% of the participants clearly stated that they would have personally liked to get more advanced training and had a more developed interest in the technology. Some of the literature reviewed argued that there was a great lack of interest by users to gain a higher level of understanding of the systems. Users training is one of key success factor for solar home system project [22]. According to Herbert Wada's manual on PV project development states that,

> "... while it is true that system maintenance is simple and theoretically be done by users, only a few households that happen to include a member with genuine interest in the system have been found to perform even the most basic preventative maintenance procedures a few months after installation. The problem seems to be simply a lack of real interest in the systems".

In situations where a well designed and implemented system maintenance program is employed by external or local technicians it may not be practical or necessary to give all users extensive technical training. In these cases it is only vital that the end users understand how to use the system and understand the system's limitations. Even with the availability of technicians many failures are caused by abuse of the system either by over consuming energy or by carelessness of the end-user. If end-users have a clear idea of each party's roles in system maintenance and repair and are adequately trained to perform their own contractual obligations many problems may be eliminated [24,25].

Generally, women in the Philippines perform most of the work related to subsistence. The survey found that women have better understanding of the system and are generally around the systems all day. They are usually responsible for looking after system. Despite the fact that this importance is broadly recognized, conscious efforts were not made in Palawan to design and implement training programs with gender-specific approaches and gender-adapted timetables to improve women's access to a broad knowledge base. Recent field experiences with many organizations have demonstrated that, "Rural Women, with modest training combined with encouragement and technical support can make a highly significant contribution to the sector" [26].

The survey results suggest that the training programs used in Palawan employed the traditional "didactic' style of training which is content-focused. In this type of training information is passed in one direction – from trainer to trainee. This didactic approach assumes that the learner's main problem is lack of knowledge. A large disadvantage of this approach is that the simple transfer of information from trainer to trainee seldom assures that the trainee will put the information to practice. As demonstrated in many of the communities in Palawan participants were able to recall the information gained in their training sessions but failed to put it into practice. Often, this type of training fails because the trainer is seen by the participant as an authority figure. So the trainee's response is generally non-committal.

There was no hands-on learning in the Palawan projects. A United Nations report that analyzed community based RE training stated that [27],

> "Hands-on training is more effective than classroom training. As a general rule, at least half of training activities should be of the hands-on type and it should as closely as possible emulate the actual equipment or activities the training is intended to support.

Despite the fact that having system owners participate in installations seems to be a very good way to transfer knowledge by 'doing', it was very apparent that installers rarely take the time to provide instructions to users. Only one Palawan participant assisted in an installation. Herbert Wada's study found that as a result of this the user has a tendency to tinker with the system sometimes causing serious damage" [23].

There is no concrete evidence or data that supports the notion that printed material used in training programs or as reference material for the end-user after installation, contributes to system sustainability. However, despite institutional efforts to maintain locally trained personnel in the communities, participants have little or no information to use as a reference if they are experiencing problems with their system. Project participants/end users in Palawan did not receive adequately complete written reference material. Upon review of the complete document set, it was determined that instead of being informative, much of the literature received by participants included contracts, legal documents, financial and payment obligations, warrantee stipulations, advertisements and documents with large red print warning users not tamper with their systems. This material should be designed to be helpful to the user and accommodate their skill level, language

and cultural considerations.

Timing has also proved to be an important consideration. In the Palawan projects the training/orientation happened well before the actual project installations. This may have been due to the fact that the user training in these projects focused more on the financial structure and warrantees than it did on technical training for operation and maintenance. The reviewed literature supports timely training programs. Users' instruction works best a few weeks after the installation. It is also better to provide detailed instruction to the users and explain it carefully by showing them practical applications.

6 Conclusion

This study has revealed some useful knowledge from the capacity development programs of SHS technology transfer projects in the Philippines. The study suggested that there is a great need to devote time and financial resources to capacity building programs that specifically target the system technicians and end-users in solar technology transfer projects. Adequate user and local technician training have proved to be an important factor in successfully implementing rural electrification through PV power systems. However, for training to be successful there must be a consensus of what the target performance ~~behaviours~~ behaviors should be and how they should be measured. The most basic requirements for successful training are that the training reaches to the right people at the right time and delivers the right content.

The need for user-training was illustrated by the fact that many of the participants of the Palawan projects have not clearly embraced the technologies but their actions regarding system maintenance, system operation, and overall understanding of system components have led to premature system failures and in some cases lack of confidence to operate or maintain the system. The Palawan projects succeeded in the delivery of electrical systems to communities that could not access an electrical grid but were designed in a way that excluded the end-user from understanding many important aspects of the system that would allow them to successfully operate and maintain the technologies. Information obtained from FGDs and literature has stated, end users do not necessarily need to understand the technicalities of their systems. However, this was proven to be true only if they were capable of performing basic maintenance and adhering to set operational guidelines. It also assumes that an adequate and effective structure is put into place for after sales maintenance. The reliance on external technicians in Palawan has left many systems abandoned and dysfunctional.

This study also proved that many factors affect the successes of capacity building programs. Technical training alone will not lead to project sustainability. Instead, project designers need to consider many social, cultural, financial and environmental factors that are often overlooked in project design. The most successful user-based training programs will be presented in a context that is familiar and relevant to the recipient's needs, ambitions, culture and level of understanding.

The responsibility to conduct comprehensive and effective training programs does not lie solely in the hands of field trainers and curriculum developers. Responsibility also rests with those who make policy decisions affecting training, specifically those who approve or disapprove funds for training resources, including the donor agencies that provide the incentives or disincentives which influence the performance of field staff.

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Highlights

- We investigate the effectiveness of the training components of solar projects in Philippines.
- Training provided by the project designers did not consider social, cultural, and financial factors.
- The training programs were not relevant to recipient's need, ambition, culture and level of understanding.

Queries and Answers

Query: Please check the address for the corresponding author that has been added here, and correct if necessary.

Answer: Checked

Query: Please note that Refs. [4] and [22] seems to be identical. Check and correct if necessary.

Answer: corrected

Query: Please note that Ref. [27] is cited in the text but not provided in the reference list. Check and provide the reference.

Answer: Added

Query: Please confirm that given names and surnames have been identified correctly.

Answer: Yes